

The University of Chicago

THE EFFECT OF ALCOHOL
ON THE HUNGER SENSE

A DISSERTATION SUBMITTED TO THE FACULTY
OF THE DIVISION OF THE BIOLOGICAL SCIENCES
IN CANDIDACY FOR THE DEGREE OF DOCTOR OF
PHILOSOPHY

DEPARTMENT OF PHYSIOLOGY

1937

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CHARLES C. SCOTT

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In 1914 Carlson and co-workers (2, 3) published their research on the action of stomachics on the gastric hunger mechanism. It was anticipated that these substances might augment hunger contractions since people had long used stomachics for improvement of poor appetite. On the contrary, it was found that hunger was not increased, but actually inhibited by alcohol or bitters. Conclusions seemed to indicate that alcohol stimulated the appetite while abolishing hunger. Cushny (4) in 1910 had proposed that stomachics acted mostly by suggestion on patients rather than by real drug action. Excluding the hunger mechanism, various investigators (5) have reported that alcohol causes an increased flow of gastric juice, while Moorhead (7) and Carlson (1) showed that various bitters had no influence on gastric secretion. In low concentrations alcohol is said also to decrease the emptying time of the stomach (Kast, 6).

The original purpose of this research was to continue the work of Carlson with alcohol in an attempt to determine more accurately the exact nature of alcohol in increasing the desire for food. It was thought that a greater insight might be obtained by *running experiments longer*, and analysing subjective sensations in more detail, since such a procedure might lead to a better understanding of the nature of appetite which at present is poorly understood. Perhaps, too, vigorous hunger contractions might follow the primary inhibition.

METHODS OF PROCEDURE WITH RESULTS. Hunger contractions were recorded by the usual balloon-in-stomach method, the balloon being connected with a water manometer writing on a kymograph record. The subject was placed in a comfortable chair with his back to the recording device so that he could not see the record. The subjects used were six healthy young males between the ages of twenty and thirty. The subject was to signal (recorded on the graph) whenever he had true hunger sensations, and was instructed not to signal for other sensations from the stomach nor for appetite. This meant that the subject had to practice signaling for hunger contractions for a time until he could always distinguish true hunger from other types of sensations. The method of signaling for hunger sensations consisted in having the subject press an

ordinary spring key in circuit with a signal magnet writing on the graph. In order to designate the various degrees of intensity of sensation, three spring keys in circuit with three separate signal magnets were used. One key, hereafter to be referred to as key I, was used to signal for sensations of mild or moderate hunger; a second, key II, represented strong hunger; the third, key III, being used to indicate hunger contractions that were experienced as disagreeable or even painful in intensity. The subject was instructed to press the key momentarily and then release it. He was then to press the key again as soon as he was sure that he still felt the hunger contraction, and so on. For example: At the beginning of a hunger contraction the subject would press the key and release it; then perhaps a second later, as the contraction became stronger he would press the key again. If the contraction continued to get stronger, it might be only a half second until he pressed the key for the third time. As the contraction would decrease in amplitude, the intervals between the signals would lengthen. In addition, if the hunger contraction were strong, the subject might start by signaling with key I as the contraction started, but as the amplitude of contraction increased he would change and signal with key II. If the contraction were very strong, he might then signal with key III. The reverse process would occur as the contraction gradually diminished and disappeared.

In the original procedure, it was decided to allow a hunger period to progress until approximately one-third finished, at which time alcohol diluted with water would be taken. The experiment would then be continued for a time considered sufficient to show what effect the alcohol would produce. The control experiments, according to the original plan, were to consist of an undisturbed hunger period with the subject recording his sensations. At the time, it was not considered advisable to interrupt the control records one-third through by drinking water equivalent in volume to the alcohol experiments, although this procedure was tried.

The strength of the alcohol solution and the total amount of alcohol to be taken by the subject was not decided on before undertaking the problem. Various amounts and dilutions were tried before a satisfactory value was obtained. Carlson, in his work, had used 50 to 100 cc. volumes in dilutions of 10 per cent with inhibition of the hunger period for one to two hours. The total quantity of alcohol amounted to 5 to 10 cc. This was considered to be too small a quantity of alcohol. It was thought that the amount should more nearly correspond to that of a cocktail or two, that is, enough alcohol to produce a moderate feeling of exhilaration or headiness. In other words, the quantity of alcohol should be equal to the amount taken ordinarily as an appetizer. In some of the experiments 100 cc. of 20 per cent alcohol was used but this seemed to be insufficient. Finally, 200 cc. of 20 per cent alcohol taken in two 100 cc. doses, about

five minutes apart, proved to be the desired amount. Consuming this quantity with the stomach empty, the effect begins to be noticed in about ten minutes; the peak of the action occurs about one-half hour after drinking, and the final effects of the alcohol last for three to four hours. It should be noted that this concentration and amount of alcohol was not distasteful to any of the subjects. Larger amounts of alcohol were taken but they proved excessive because the subject approached the state of drunkenness in which he could hardly keep awake or was unable to concentrate properly on his task.

TABLE 1
Average values of first series of experiments

	CONTROL EXPERIMENTS			ALCOHOL EXPERIMENTS		
	Subject 1	Subject 2	Average of all results	Subject 1	Subject 2	Average of all results
First twenty minutes of hunger period:						
Average number of hunger contractions..	13.0	10.0	11.5	14.0	11.0	12.5
Average height of hunger contractions (cm.).....	6.0	8.3	7.2	6.5	8.6	7.5
Average sensation per hunger contraction	10.1	11.0	10.6	15.0	14.1	14.6
Period of quiescence in minutes.....	Continuous with first part			38.0	45.0	41.5
Remainder of hunger period:						
Average number of hunger contractions..	31.0	21.0	26.0	34.0	26.0	30.0
Average height of hunger contractions (cm.).....	8.7	12.3	10.5	7.5	10.6	9.0
Average sensation per hunger contraction	30.0	28.1	29.0	37.1	31.3	34.2
Per cent of experiments showing tetany..	63.0	66.0	64.5	90.0	66.0	78.0
Average duration of tetany in minutes...	7.5	4.0	5.7	5.6	5.0	5.3

Table 1 shows the results of the early experiments in which the hunger period was interrupted one-third the way through by the taking of alcohol. The intensity of the *hunger sensation* was calculated by dividing the total number of signals by the total number of hunger contractions. Signals from keys I, II, and III were given a value of one, two, and three respectively. These were added together to give the total number of signals. The results show an intensity of sensation 18 per cent greater in the alcohol experiments than the control. Looking at the records, however, one is impressed that the difference should have been much greater. In other words, the methods used evidently were masking the full effect of alcohol in increasing the *feeling of hunger*. It was decided that the explanation

of this lay in the fact that the control periods were uninterrupted so that the contractions following the first third of the period were undisturbed and consequently of good size. In the alcohol experiments, a period of inhibition always results after which the remaining two-thirds of the hunger period is finished. The onset of this last part of the hunger period after the alcohol interruption is marked by contractions which are small since the contractions do not commence at full amplitude but gradually build up again. So the method used to compare alcohol and control experiments partially obscured the alcohol effects, because the small hunger contractions at the onset of the last part of the period produce only mild sensations, whereas the corresponding contractions in the controls were large with consequently greater intensity of hunger.

It is also notable that the average height of the hunger contractions was greater in the controls, although a glance at the records showed no particular difference in height. This difference could be explained again on the basis that the *temporary inhibition* with alcohol and the gradual increase in amplitude thereafter caused a lowering of the average height of contractions since the control periods were not interrupted.

In view of the fact that the control experiments did reveal a higher average amplitude of hunger contractions, the greater intensity of hunger sensation in the alcohol experiments is all the more striking because *contractions averaging smaller were felt more strongly than large contractions*. It seemed apparent that if the average amplitude of contractions could be made the same in the control and alcohol tests, the intensity of sensation would be even greater in the alcohol experiments.

Since the comparison between the alcohol and control records was not perfectly satisfactory, it was decided that the procedure should be changed in order to obtain records of hunger contractions as nearly alike as possible experimentally. The results had shown that alcohol produced a much shorter period of inhibition of hunger than reported by Carlson, although in this work considerably larger doses of alcohol were taken. However, alcohol inhibition was not the purpose of this research so the decision was made to take either alcohol or water in equivalent volumes directly after starting the record and before the hunger period had begun. The volume would be 200 cc., using 20 per cent alcohol for the tests and tap water for the controls, in both cases at room temperature. After starting the record in this manner, it would be run until a hunger period developed and was completed. In addition, in order to simplify and increase the accuracy in determining the number of the hunger signals on the graphs, three automatic counters were connected in series with the three signal keys used by the subject to denote hunger sensations on the record. In the first series of experiments the hunger signals on the graphs were counted by using a small ten-power magnifying glass, which was necessary

because the signals often recorded very close together. The counting represented a laborious task and, undoubtedly, was not as accurate as an automatic counter. The type of counter used was the simple Veedor type actuated by means of a soft iron rod which was pulled through a coil whenever the signal key was pressed.

Table 2 represents the average of the results of all the experiments run in this second series. The new method of experimentation proved to be much more satisfactory in that the alcohol and control tests were practically alike, thus enabling a more accurate determination of the alcohol effect on the hunger sense. The most striking difference between the control and alcohol records is in the hunger sensations. The average intensity of hunger sensations in the alcohol graphs was 105 per cent greater than in the controls. In addition, when we compare the other

TABLE 2
Average values of second series of experiments

	CONTROL EXPERIMENTS							ALCOHOL EXPERIMENTS						
	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Average of all results	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	Average of all results
Average time elapsing between taking fluid and start of hunger period in minutes.....	13.0	9.5	11.0	41.0	20.0	59.0	26.0	33.0	8.5	72.0	69.0	41.0	78.0	50.0
Average number of hunger contractions.....	37	28	37	46	30	37	36	49	54	39	19	22	43	38
Average height of hunger contractions (cm.).....	7.3	7.8	6.5	5.4	9.2	7.7	7.3	6.5	9.4	7.8	10.4	4.8	6.6	7.6
Average sensation per hunger contraction.....	16.9	14.7	11.9	11.2	16.6	13.2	14.1	30.3	21.8	16.3	27.9	31.1	46.1	28.9
Per cent of experiments showing tetany.....	50	50	0	100	100	50	58	50	100	0	100	0	50	50
Average duration of tetany in minutes.....	5.5	5.0	0	9.0	6.5	12.0	7.4	5.0	5.5	0	4.0	0	9.0	5.9

factors in the table we notice only a slight difference. The hunger contractions appeared twenty-four minutes sooner after taking water than in the case of alcohol, whereas the period of alcohol inhibition in the first series averaged forty-one minutes. The number of contractions to the hunger period showed approximately the same average in alcohol and control experiments for the group as a whole, but there were individual variations in both directions. As had been expected, the average height of contractions in the alcohol series was much more similar to the control contractions than in series I.

DISCUSSION. These results show that alcohol has little effect on the hunger period except for some delay in the onset of the contractions. Once hunger has appeared, the contractions are so similar in alcohol and control tests as to be indistinguishable. However, the striking difference

lies in the degree of hunger experienced by the subject. *Alcohol markedly increases the intensity of the hunger sensations without increasing the height of the contractions.*

The fact that alcohol produced such an intensification of hunger in all subjects is strong evidence against suggestive effects, since the subjects were not informed as to any possible action of alcohol. In all cases, however, on being questioned after the experiments, the subjects were convinced that they felt the hunger much more intensely when alcohol was taken. This is further amplified by the fact that many small hunger contractions that passed unheeded in control experiments were easily recognized with alcohol. It is evident that some factor enhances the ability of the subject to feel hunger when alcohol is administered although the nature of this enhancement has not been determined. However, there appear to be three possible modes of action of alcohol which would intensify hunger sensations: 1, increased sensitivity of the nerve endings in the muscular layer of the stomach wall; 2, a process of facilitation or Bahnung of centers in the brain which experience hunger; 3, a depression of higher centers or higher functions of the brain with a relative increase in the importance of lower functions. It is thought that the third possible mode of action is the most applicable in this instance, because of the general agreement of investigators (8) that moderate amounts of alcohol act primarily by depression of the higher centers. If this is true, neither of the first two possibilities could operate. There is much in favor of this view, however. Many investigators agree that alcohol acts first on activities of the cerebral cortex which are developed or acquired through education, leaving more primitive sensations and emotions practically unaffected, at least temporarily. The hunger sense is presumably a lower type of sensation because of its universality and necessity. Hence, alcoholic depression of higher functions should produce a greater ability to sense the contractions of the empty stomach, that is, an intensification of the hunger sense.

So far the question of appetite has not been discussed. Carlson had concluded that the stimulating effect of alcohol must have been on appetite since hunger was inhibited. In this work, no method of measuring appetite was developed. If appetite is a true sensation, it is certainly more vague than hunger. In fact, appetite is not well understood, some disagreement existing as to its definition. However, the subjects were instructed to note what effect the alcohol had on the desire for food during the period preceding the onset of hunger contractions. Here again, in all cases, alcohol stimulated the desire for food. The first sensation produced by alcohol in the stomach was a peculiar feeling of warmth that was agreeable, but which was not interpreted as a desire for food. This sensation would disappear in less than five minutes and be followed by

a more vague feeling, definitely referred to the epigastrium, which was interpreted as a distinct desire for food. This epigastric sensation, difficult to describe, was continuous and less intense than hunger. The general opinion was that this feeling was one of moderate tenseness in the epigastrium, but an examination of the records revealed no increase in gastric tone. Some investigators might not consider this sensation to be appetite since they feel that appetite is not referred to the stomach at all but is experienced in the mouth and throat and is based on previous pleasant memories connected with food. Employing the term in this sense, these results could not be interpreted to mean that alcohol had increased the subject's appetite, since the sensation was definitely referred to the stomach region. However, since the sensation was one which was definitely interpreted as a desire for food, and since there were no hunger contractions present, there is apparently no choice except to pronounce this feeling appetite. Incidentally, in some of the subjects, this increased appetite sensation was interpreted as producing more desire for food than the hunger which followed.

It is seen from the above discussion that alcohol apparently has two actions: A preliminary one which increases the appetite, and a second action of intensifying hunger sensations. This can be interpreted in terms of the experiences of any one who has taken alcoholic beverages. It is a fairly common practice to drink a cocktail or two before eating dinner, partly because it seems to stimulate ability to eat and enjoy food. Now since the period between drinking and eating would ordinarily be too short for hunger to appear, the increased desire for food must be concerned with the first factor mentioned above, namely, appetite stimulation. This would be more reasonable than a stimulus to hunger sensation in view of the fact that as soon as food is eaten, hunger immediately ceases, whereas alcoholic beverages seem to stimulate one's desire for food for some time after food-taking has commenced. Consequently, the hunger intensifying action must operate under different conditions. This action could occur with the empty stomach, the individual taking a few drinks of liquor and not eating immediately afterwards. Thus a drink or two late in the afternoon or late at night would allow the hunger to return, to be felt more acutely than if no alcohol had been taken. It is a quite common experience that after attending a party during which time a few rounds of drinks are consumed one feels that he must eat before going to bed. This could be explained on the basis of the second action of alcohol and the action which has been determined in this experimentation although the appetite factor may not be entirely eliminated.

SUMMARY

A method of recording the intensity of hunger sensations was developed which made it possible to study the action of alcohol in relation to hunger.

It was found that the hunger contractions, which occurred after the primary inhibitory effect due to the ingested alcohol, produced *hunger sensations* which were more intense, even slight hunger contractions producing hunger pangs compared with the inconsequential effect of similar contractions occurring in a control period. Alcohol did not increase the amplitude of hunger contractions. In addition, alcohol produced an epigastric sensation during the period of alcohol inhibition preceding the hunger contractions. This feeling was associated with an increased desire for food, but was less intense than hunger and continuous; consequently, it was considered to be appetite.

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